

METHOD AND DEVICE FOR CONTROLLING THE  
WORT FLOW FROM A LAUTER TUN

Description

The present invention relates to a method for controlling the wort flow from a lauter tun and a device for performing such a method.

A method for controlling wort outflow during brewing is, for instance, known from the European patent application EP-A-0362 793. In this method, the wort outflow quantity is measured and compared with a predeterminable outflow value. This outflow value serves as a set value, the actually measured wort outflow quantity serving as an actual value. The raking machine which is arranged within the lauter tun is lifted or lowered in response to the difference between the actual value and the set value. When the flow rate of the wort decreases, the raking device is moved into a lower position to loosen the grain bed which has settled on the false bottom of the lauter tun. The resistance of the grain bed is reduced by the loosening operation, so that the wort flow rate can be increased. The time needed for lautering the wort on the whole can be reduced. There may also be set different outflow values in different phases so as to be able to work with corresponding suitable outflow values in

the individual sections (first wort recovery, second worts).

Although the lauter time can be reduced with this method, the lauter process remains, in the present method, that process in wort production that requires most of the time and should therefore be further reduced with a view to a further increase in the brew sequence, i.e., without impairment to the wort quality. Furthermore, it is desirable to have possibilities of individual adaptation for the most different types of beer, raw material compositions, grist compositions, mash consistencies and loads on the lauter tuns.

It is therefore the object of the present invention to further shorten the time for lautering the wort in a method and in a device of the above-mentioned type, with such a shortening being possible under the most different conditions and with the most different types of beer, raw material compositions, etc.

This object is achieved according to the invention in that in the course of the total sequence of a brew process (first wort, second worts) a second increased outflow value which is to be reached within a specific time interval is predetermined in at least one phase (trending phase), based on the predetermined outflow value of the wort outflow, that the increase in flow rate/per time unit (increase value) as required for reaching the second outflow value is determined on the basis of these values, and that this

determined increase value is used as a set value for controlling an outflow regulator.

Hence, at least one phase, which may be designated as trending, is included in this invention in a complete lauter process which ranges from the first wort recovery to the second worts. In this phase, the wort outflow quantity is not regulated to have a constant wort outflow value, but is regulated on the basis of a rising, especially staircase-like outflow curve which can be determined in that, by setting a specific increased outflow quantity which is to be reached after a certain time, the resultant rise is calculated for the increase in flow rate per time unit (set value).

The outflow quantity can be varied by regulating the effective flow opening of a regulating valve, but also by regulation via the opening angle of a lauter flap.

In a very advantageous embodiment of the invention, the raking machine provided within the lauter tun is included in or combined with the control loop for controlling the outflow quantity according to EP-A-0326 793.

This may advantageously be done in that, when a specific stepwise increase in the opening angle of the lauter flap by a specific angular amount (e.g. 8%) does not yield a corresponding increase in the flow rate during the trending phase, the raking machine is slightly lowered to effect an increase in the outflowing wort amount.

This trending phase may be carried out until the second increased outflow value has been reached or until the flap position has reached a limit value which is also predeterminable (e.g. 80% total opening angle), so that a further increase no longer yields a significant increase in flow rate.

It is advantageous in the course of the trending phase when the set value can be varied. In particular, the set value is reduced if an increased flow rate of the wort cannot be reached, whereby the grain bed is prevented from getting stuck or from solidifying. This would lead to a deep cut which is not desired in the trending phase. As soon as the flow rate of the wort has stabilized over a certain period of time, the increase in the flow rate per time unit is continued with the original set value.

In a lauter tun of the type as described at the outset, the device for performing the method provides for an outflow regulator which is connected to the control means for regulating the amount of the outflowing wort.

This measure makes it possible to perform the method, since the outflow regulator can then be included in the control loop and can automatically be influenced by the control means in accordance with the respectively desired values.

The invention shall now be explained in more detail with reference to the embodiment illustrated in the drawing, in which:

- Fig. 1 is a diagrammatic view of a device having a structure according to the invention; and
- Fig. 2 is a diagrammatic explanatory sketch for illustrating the principle of the invention; and
- Fig. 3 shows an actual sequence program measured during testing for further explanation of the method of the invention.
- Fig. 4 diagrammatically illustrates the desired flow rate value and the actual flow rate value as a function of time.

The device comprises a lauter tun 1 which may be arranged on a support device (not shown) for creating an installation place below bottom 2 of lauter tun 1 for the installation of a drive device 3 and a lifting and lowering device 4 for the raking device 5 which is arranged within lauter tun 1. The raking device 5 comprises a drive shaft 6 which is supported in a rotational and axially displaceable manner. A plurality of horizontal arms 8 of which each supports a number of raking knives 9 for a grain bed which during the lautering process settles as residue on the false bottom 10 of lauter tun 1 are circumferentially secured in equally spaced-apart relationship in the upper end section 7 of drive shaft 6. With its lower end section 11, drive shaft 6 of the raking device is in engagement with the drive means 3 and the lifting and lowering device 4.

The lauter wort which has been removed from lauter tun 1 passes via a discharge pipe 12 into collecting pot 13 and from said pot into a central pipe 14 which has arranged downstream thereof a flow rate meter 15 and an outflow regulator 16. The flow rate of the lauter wort can be measured with the aid of the flow rate meter 15.

Flow rate meter 15 is connected to control means 17 which, in turn, is connected to a regulating element 18 of outflow<sup>10</sup> regulator 16 and to drive device 3 of the lifting and lowering device 4 of raking device 5.

The drive motors for the lifting and lowering device and for the rotational movement of the raking device are designated by M.

The method according to the invention can be carried out with this device as follows:

- or a regulating valve*
- <sup>10</sup> At the beginning of the lautering process, the initial height of the raking machine, the flow rate and the opening angle of the lauter flap are defined. The flow rate value depends on the composition of the grist, the type of beer,
  - <sup>4</sup> the raw material used, etc. A suitable flow rate value is then defined in accordance with empirical values, and the
  - <sup>20</sup> opening angle of the lauter flap is set accordingly. These values are maintained up to a specific adjustable total lauter amount or a specific adjustable lauter time, and the raking machine is optionally used to maintain the desired
  - <sup>30</sup> flow rate. This value, to which the flow rate is first set,

is designated in Fig. 2 by A1 and represents the first outflow value. This value may, for instance, be 300 or 350 hl/h or a corresponding proportional flow rate value.

Upon initiation of the trending phase according to the invention, a second, considerably increased flow rate value or a correspondingly increased proportional flow rate value A2 is supplied to control means 17, and the control means is informed about the time T within which this considerably increased outflow value A2 is to be reached. The control means can then calculate rise S. This increase in the flow rate per time unit as represented by rise S is then given as a set value to the control means of the outflow regulator during the trending phase.

Fig. 3 illustrates an actually measured diagram which discloses a whole lautering process in time sequence and in coordination of the individual parameters.

Reference numeral 20 designates the course of turbidity, reference numeral 30 the flow rate in %, reference numeral 40 the lift of the raking machine in mm, reference numeral 50 the total flow in hl, reference numeral 60 the prevailing overpressure in the lauter tun, and finally, reference numeral 70 the opening angle of regulating valve 16.

As can easily be seen in the left half of the illustrated diagram, the control of the outflow quantity, especially with first wort recovery, is essentially performed according to two different set values up to the time of about 1.2

hours. The one set flow-rate value is represented by the line in which reference numeral 30 ends in the flow rate curve (in percentage), whilst trending with the increase value for the flow rate per time unit can be seen as set value at the right next to the deep-cut curve (peak at 1.25 h in Fig. 3). An increase in flow rate 30a is accompanied by the feeding of  $\text{CO}_2$  into the lauter tun. With a decrease in the  $\text{CO}_2$  content, the opening angle of the regulating valve 16 is further increased to be able to keep the set flow-rate value constant. After a certain angular position has been reached, the set value is no longer maintained by further opening the angle of the regulating valve, but lowering of the raking machine is additionally started, as can be seen by looking at the raking-machine lifting-height curve 40. Nevertheless, if the flow rate decreases further, a first deep cut is made, and the trending phase is then initiated. To this end, the control means 17 is given a greatly increased set flow-rate value which is to be reached within a specific period, for instance, after a total of 30 minutes from the beginning of the trending phase. To enable the actual value curve 30 of the flow rate to follow the calculated increase, the opening angle of the regulating valve 16 is increased stepwise, as shown by curve 70. As can be seen from the right portion of the spectrum, this leads, after some time, to a situation in which a distinct increase in the opening angle (see the two peaks in curve 70 in the right edge portion of the spectrum) no longer entails an increase in flow rate as is desired (see right upper corner of the diagram in which the flow curve is oriented downwards although the opening angle curve has strong peaks. In such

a situation the raking machine (see curve 40) is slightly lowered, thereby contributing to the increase in flow rate. Finally, when either the opening angle of the outflow regulator has reached a maximum value, for instance 80% of its total opening angle, or when the upper outflow value has been reached, the trending phase will be terminated.

If in the course of the trending phase the desired flow rate increase is no longer attained, the set value, i.e. the flow rate per time unit, can be reduced at the same time as the lowering of the raking machine and the resultant loosening of the grain bed. Such a situation is illustrated in Fig. 4. Lautering of the wort is, for instance, assumed to begin at an outflow value of 200 hl. Such a value represents the first outflow value A1 and is fixed, for instance, for the duration of 5 minutes. The trending phase will then start. An increased second outflow value A2 of for instance 560 hl is predetermined. The second increased outflow value is to be reached within one hour. When the control means is given this time value, it will calculate a rise (S) in the flow rate per time unit of 360 hl per hour, or 2 hl every 20th second. On the basis of the first flow rate value A1, this value is now increased by 2 hl every 20th second in a kind of staircase function. The flow rate value 80 which is now desired after the first 20 seconds is 202 hl. It is found out by comparing this desired value with the actually measured real value 90 whether the desired value has been reached within the period set therefor. If this is the case, the instantaneous flow rate value of 202 hl is again increased by 2 hl to

204 hl. After 20 seconds have passed, a comparison is again made to find out whether the newly desired flow rate value of 204 hl corresponds to the actual real value. This procedure will be repeated until the second flow rate value A2 of 560 hl has been reached. In view of the given set value (S) and the rise of 360 hl per hour or 2 hl every 20th second, this should be the case after one hour.

In addition to the respectively desired flow rate value 80, control means 17 calculates a lower limit value 95 for the actual flow rate 90, the lower limit value 95 being, for instance, 4 hl below the respectively desired flow rate value 80. Should the desired flow rate value 80 not be reached in the course of the trending phase, and should the actual real value 90 for the flow rate rather fall below the limit value 95 for the flow rate, the set value (s) will be decreased by a predetermined amount. For instance, the set value of formerly 2 hl every 20th second may be lowered to minus 4 hl every 20th second. This means that, at a desired flow rate value of, for instance, 380 hl after a running time of 30 minutes of the trending phase, said value is reduced by reducing the set value to 376 hl. On the basis of this newly desired flow rate value 80, a new lower limit value of 372 hl which is reduced by the same amount of 4 hl every 20th second is now calculated. If this new limit value of 372 hl is also not reached within the next time interval of 20 seconds, the above sequence will be repeated until a lower limit value for the flow rate is reached. At the same time, when the first lower limit value is not reached, the control means 17 lowers the raking machine, whereby the grain bed is loosened and the flow

rate is increased. If the flow rate is not lowered any more, so that it is not possible to fall below a further limit value, the instantaneously desired flow rate value 80 will be maintained until the flow rate remains constant over a predetermined period of time or increases again. As soon as this is the case, the trending phase will be continued with the original increase value or set value (s) of 2 hl every 20th second so as to increase the flow rate per time unit, i.e., a desired flow rate value of 376 hl is again increased by 2 hl every 20th second to 378 hl.

Since the set value is reduced, resulting in a lowering of the flow rate, the grain bed cannot get stuck on account of a suction effect, which would otherwise be the case with an increasing opening of the regulating valve 16 for achieving an increased flow rate. In such a case it would only be possible to loosen the grain bed solidified in this manner by way of a deep cut, which is not desired.

- As becomes apparent from the diagram according to Fig. 3, it is possible with the method of the invention in the illustrated embodiment to lauter a total lauter amount of about 650 hl within a period of about 100 minutes, whereas 150 to 165 minutes are required for this purpose for a similar amount in the method described in EP-A-0362 793. The method of the invention thus entails very considerable advantages with respect to the shortening of the total lauter time. Moreover, an individual adaptation to the most different conditions is possible due to the performance of the trending phase and in view of the respectively given conditions by setting different second outflow values

(upper flow value), so that it is possible to shorten the  
lauter time under the most different preconditions.

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